8206M

FOLD-RESISTANT CLEANING SHEET

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Cross Reference to Related Applications

This application claims priority under 37 U.S.C. § 119(e) to U. S. Provisional Application Serial No.60/226,424, filed August 18, 2000 (Attorney Docket No. 8206P) and to U. S. Provisional Application Serial No. 60/237,835, filed October 3, 2000 (Attorney Docket No. 8206P2).

Field of the Invention

The present invention relates to cleaning sheets that resist folding, especially refolding upon themselves even after an initial fold has been formed in the cleaning sheets, such as an initial fold formed for packaging reasons.

Background of the Invention

Conventional cleaning sheets, especially those that are used in laundry dryers, have a strong tendency to refold upon themselves, especially during use.

When cleaning sheets refold upon themselves, they reduce the surface area and thus, the ability of the cleaning sheets to optimize the release of any cleaning ingredients contained on and/or in the cleaning sheet.

Accordingly, there is a need to develop cleaning sheets that resist folding, especially refolding upon themselves, even after an initial fold has been formed in the cleaning sheets.

Summary of the Invention

The present invention fulfills the need by providing cleaning sheets, especially cleaning sheets used in dryers, that resist folding, especially refolding upon themselves.

It is known that materials have "memory" or lack thereof with respect to the desired physical state/shape of the materials. For example, with respect to conventional cleaning sheets they are oftentimes initially folded, at least one time and commonly more, in order to be packaged. Such fold lines created in conventional cleaning sheets create a memory in the cleaning sheets such that even after unfolding the cleaning sheets the cleaning sheets have a tendency to refold along the initial fold lines, especially when the cleaning sheet is tumbled, as in the case of use in an automatic clothes dryer.

It has surprising been found that the cleaning sheets of the present invention resist folding, especially refolding after an initial fold has been created in the sheet, such as an initial fold for packaging reasons. In other words, the cleaning sheets of the present invention do not retain the "memory" of being folded initially, unlike conventional cleaning sheets.

In one aspect of the present invention, a cleaning sheet comprising a material, preferably the chemical composition of which is such that the material resists folding is provided.

In another aspect of the present of invention, a cleaning sheet comprising one or more apertures that resists folding is provided.

In yet another aspect of the present invention, a cleaning sheet comprising an inner sheet and an outer sheet that wholly or partially encases the inner sheet such that the cleaning sheet resists folding is provided.

In still another aspect of the present invention, a cleaning sheet comprising at least two layers of material, wherein the layers are such that when an initial fold line is formed in the cleaning sheet the fold line in the two layers are aligned, and then upon use of the cleaning sheet the fold line in the two layers become nonaligned such that the cleaning sheet resists folding, is provided.

In still yet another aspect of the present invention, an overall non-immerion cleaning/refreshment process for treating a fabric, which optionally comprises a prespotting operation, comprising the overall steps of:

a) placing the fabric together with a cleaning sheet in accordance with the present invention in a tumbling apparatus; and
b) operating the tumbling apparatus, is provided

In still yet another aspect of the present invention, a kit comprising a plurality of cleaning sheets in accordance with the present invention is provided.

In even still yet another aspect of the present invention, a kit comprising:

a) one or more cleaning sheets in accordance with the present invention; and
b) a re-usable containment bag, is provided.

In even still yet another aspect of the present invention, a kit comprising:

a) one or more cleaning sheets in accordance with the present invention; and
b) a stain remover system, is provided.

In addition to resisting folding, the cleaning sheets of the present invention provide reduce and/or inhibit liquid transfer from the cleaning sheets to articles in contact with the cleaning sheets.

Accordingly, the present invention provides a cleaning sheet that resists folding, especially refolding upon itself, even after an initial fold has been formed in the cleaning sheet; processes for using such cleaning sheets, and kits comprising such cleaning sheets.

These and other objects, features and advantages of the present invention will be recognized by one of ordinary skill in the art from the following description and the appended claims.

All percentages, ratios and proportions herein are on a weight basis unless otherwise indicated. All documents cited herein are hereby incorporated by reference.

Brief Description of the Drawings

FIG. 1 is a perspective of one embodiment of a laminate web of the present invention.

FIG. 2 is a cross-sectional view of a portion of the laminate web shown in Figure 1.

FIG. 3 is a magnified detail view of one bond site of a laminate web of the present invention.

FIG. 4 is a top plan view of another embodiment of the laminate web of the present invention.

FIG. 5 is a cross-sectional view of a portion of the laminate web shown in Figure 4.

FIG. 6 is a top plan view of another embodiment of the laminate web of the present invention.

FIG. 7 is a cross-sectional view of a portion of the laminate web shown in Figure 6.

FIG. 8 is a photomicrograph of one embodiment of a laminate web of the present invention.

FIG. 9 is a schematic representation of a process for making a laminate web of the present invention.

FIG. 10 is a perspective view of a melt bond calendaring apparatus.

FIG. 11 is a schematic representation of a pattern for the protuberances of the calendaring roll.

FIG. 12 is a perspective view of an apparatus for stretching a laminate of the present invention to form apertures therein.

FIG. 13 is a cross-sectional view of a portion of the mating portions of the apparatus shown in FIG. 12.

FIG. 14 is a perspective view of an alternative apparatus for stretching a laminate of the present invention in the cross-machine direction to form apertures therein.

FIG. 15 is a perspective view of another alternative apparatus for stretching a laminate of the present invention in the machine direction to form apertures therein.

FIG. 16 is a perspective representation of an apparatus for stretching a laminate of the present invention in both the cross-machine and machine directions to form apertures therein.

FIG. 17 is a perspective view of a disposable absorbent article having components that can be made of laminate web material of the present invention.

FIG. 18 is a schematic illustration of an embodiment of a cleaning sheet in accordance with the present invention.

FIG. 19 is a schematic cross-sectional view of an embodiment of a cleaning sheet in accordance with the present invention.

FIG. 20 is a schematic cross-sectional view of an embodiment of a cleaning sheet in accordance with the present invention.

Detailed Description

Definitions

"Resists folding" - "Resists folding" as used herein means that the cleaning sheet of the present invention has a tendency to remain in or return to an unfolded state if folding forces are exerted on the cleaning sheet, preferably as compared to conventional cleaning sheets.

As used herein, the term "absorbent article" refers to devices that absorb and contain fluids (e.g., water, cleansers, conditioners, polishes, body exudates). In certain instances, the phrase refers to devices that are placed against or in proximity to the body of the wearer to absorb and contain the various exudates discharged from the body. In other instances, the phrase refers to articles that have the ability to absorb and retain the benefit component until such time when the article is utilized by a consumer for its intended purpose.

The term "disposable" is used herein to describe articles of the present invention which are not intended to be laundered or otherwise restored or extensively reused (i.e., preferably, they are intended to be discarded after 25 uses, more preferably, after about 10 uses, even more preferably, after about 5 uses, and most preferably, after about a single use). It is preferred that such disposable articles be recycled, composted or otherwise disposed of in an environmentally compatible manner. A "unitary" disposable article refers to disposable articles that are formed of separate parts united together to form a

coordinated entity so that they do not require separate manipulative parts like a separate holder and liner.

As used herein, the term "nonwoven web", refers to a web that has a structure of individual fibers or threads which are interlaid, but not in any regular, repeating manner. Nonwoven webs have been, in the past, formed by a variety of processes, such as, for example, meltblowing processes, spunbonding processes and bonded carded web processes.

As used herein, the term "microfibers" refers to small diameter fibers having an average diameter not greater than about 100 microns.

As used herein, the term "meltblown fibers" refers to fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g., air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter, which may be to a microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers.

As used herein, the term "spunbonded fibers" refers to small diameter fibers that are formed by extruding a molten thermoplastic material as filaments from a plurality of fine, usually circular, capillaries of a spinneret with the diameter of the extruded filaments then being rapidly reduced by drawing.

As used herein, the term "polymer" generally includes, but is not limited to, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible geometrical configurations of the material. These configurations include, but are not limited to, isotactic, syndiaotactic and random symmetries.

As used herein, the term "elastic" refers to any material which, upon application of a biasing force, is stretchable, that is, elongatable, at least about 60 percent (i.e., to a stretched, biased length, which is at least about 160 percent of its relaxed unbiased length), and which, will recover at least 55 percent of its elongation upon release of the stretching, elongation force. A hypothetical example would be a one (1) inch sample of a material which is elongatable to at least 1.60 inches, and which, upon being elongated to 1.60 inches and released, will recover to a length of not more than 1.27 inches. Many elastic materials may be elongated by more than 60 percent (i.e., much more than 160 percent of their relaxed length), for example, elongated 100 percent or more, and many of

these materials will recover to substantially their initial relaxed length, for example, to within 105 percent of their initial relaxed length, upon release of the stretch force.

As used herein, the term "nonelastic" refers to any material which does not fall within the definition of "elastic" above.

As used herein, the term "extensible" refers to any material which, upon application of a biasing force, is elongatable, at least about 50 percent without experiencing catastrophic failure.

The articles of the present invention comprise the following essential components.

Material Composition of the Cleaning Sheet

The cleaning sheets of the present invention are preferably made of a material, the chemical composition of which is such that the material resists folding. Preferably, the material comprises a polymer. More preferably, the material comprises a viscoelastic material.

Preferably the materials for use in the cleaning sheets of the present invention are nonwovens. Suitable nonwoven materials include, but are not limited to, cellulosics, sponges (i.e., both natural and synthetic), formed films, battings, and combinations thereof.

Nonlimiting examples of synthetic materials useful in the nonwoven materials include those selected from the group consisting of acetate fibers, acrylic fibers, cellulose ester fibers, modacrylic fibers, polyamide fibers, polyester fibers, polyolefin fibers, polyvinyl alcohol fibers, rayon fibers, polyethylene foam, polyurethane foam, and combinations thereof. Examples of suitable synthetic materials include acrylics such as acrilan, creslan, and the acrylonitrile-based fiber, orlon; cellulose ester fibers such as cellulose acetate, arnel, and acele; polyamides such as nylons (e.g., nylon 6, nylon 66, nylon 610, and the like); polyesters such as fortrel, kodel, and the polyethylene terephthalate fiber, polybutylene terephalate fiber, dacron; polyolefins such as polypropylene, polyethylene; polyvinyl acetate fibers; polyurethane foams and combinations thereof. These and other suitable fibers and the nonwovens prepared therefrom are generally described in Riedel, "Nonwoven Bonding Methods and Materials," Nonwoven World (1987); The Encyclopedia Americana, vol. 11, pp. 147-153, and vol. 26, pp. 566-581 (1984); U. S. Patent No. 4,891,227, to Thaman et al., issued January 2, 1990; and U. S. Patent No. 4,891,228, each of which is incorporated by reference herein in its entirety.

Nonwovens made from natural materials consist of webs or sheets most commonly formed on a fine wire screen from a liquid suspension of the fibers. See C.A.

Hampel et al., The Encyclopedia of Chemistry, third edition, 1973, pp. 793-795 (1973); The Encyclopedia Americana, vol. 21, pp. 376-383 (1984); and G.A. Smook, Handbook of Pulp and Paper Technologies, Technical Association for the Pulp and Paper Industry (1986); which are incorporated by reference herein in their entirety.

Natural material nonwovens useful in the cleaning sheets of the present invention may be obtained from a wide variety of commercial sources. Nonlimiting examples of suitable commercially available paper layers useful herein include Airtex®, an embossed airlaid cellulosic layer having a base weight of about 71 gsy, available from James River, Green Bay, WI; and Walkisoft®, an embossed airlaid cellulosic having a base weight of about 75 gsy, available from Walkisoft U.S.A., Mount Holly, NC.

Additional suitable nonwoven materials include, but are not limited to, those disclosed in U. S. Patent Nos. 4,447,294, issued to Osborn on May 8, 1984; 4,603,176 issued to Bjorkquist on July 29, 1986; 4,981,557 issued to Bjorkquist on January 1, 1991; 5,085,736 issued to Bjorkquist on February 4, 1992; 5,138,002 issued to Bjorkquist on August 8, 1992; 5,262,007 issued to Phan et al. on November 16, 1993; 5,264,082, issued to Phan et al. on November 23, 1993; 4,637,859 issued to Trokhan on January 20, 1987; 4,529,480 issued to Trokhan on July 16, 1985; 4,687,153 issued to McNeil on August 18, 1987; 5,223,096 issued to Phan et al. on June 29, 1993 and 5,679,222, issued to Rasch et al. on October 21, 1997; 5,628,097 issued to Benson et al. on May 13, 1997; 5,916,661 and 5,658,639, both issued to Benson et al. on June 29, 1999; each of which is incorporated by reference herein in its entirety.

Methods of making nonwovens are well known in the art. Generally, these nonwovens can be made by air-laying, water-laying, meltblowing, coforming, spunbonding, or carding processes in which the fibers or filaments are first cut to desired lengths from long strands, passed into a water or air stream, and then deposited onto a screen through which the fiber-laden air or water is passed. The resulting layer, regardless of its method of production or composition, is then subjected to at least one of several types of bonding operations to anchor the individual fibers together to form a self-sustaining web. In the present invention the layers that comprise nonwovens can be prepared by a variety of processes including, but not limited to, air-entanglement, hydroentanglement, thermal bonding, and combinations of these processes.

Nonlimiting examples of cleaning sheet materials are described in detail in U.S. Patent No. 5,789,368, to You et al. which was incorporated herein by reference above. The manufacture of these sheets forms no part of this invention and is already disclosed in the literature. See, for example, U.S. Patents 5,009,747, Viazmensky, et al., April 23,

1991 and 5,292,581, Viazmensky, et al., March 8, 1994, which are incorporated herein by reference.

Additional nonlimiting examples of cleaning sheet materials comprise a binderless (or optional low binder), hydroentangled absorbent material, especially a material which is formulated from a blend of cellulosic, rayon, polyester and optional bicomponent fibers. Such materials are available from Dexter, Non-Wovens Division, The Dexter Corporation as HYDRASPUN®, especially Grade 10244 and 10444. The manufacture of such materials forms no part of this invention and is already disclosed in the literature. See, for example, U.S. Pat. Nos. 5,009,747, Viazmensky, et al., Apr. 23, 1991 and 5,292,581, Viazmensky, et al., Mar. 8, 1994, incorporated herein by reference.

a. Viscoelastic Materials

Viscoelastic materials include, but are not limited to, non-Newtonian fluids/materials. Non-Newtonian fluids/materials are known to those of ordinary skill in the art.

Viscoelasticity is defined by the following equation, which is well known to those of ordinary skill in the art and is described in Introduction to Rheology; H.A.Barnes, J.F.Hutton, K.Walters; Elsevier Publishing; Copyright 1989; ISBN: 0444-871-40-3:

$$G^* = G' + i\,G''$$

where G^* is complex shear modulus, G' is storage modulus, G'' is loss modulus and i is the square root of -1. The storage modulus (G') is a measure of polymer elasticity while the loss modulus (G'') is associated with the viscous energy dissipation (i.e., damping) by the polymer. The ratio of G'' to G' is also a measure of damping (also called tan δ):

$$\tan \delta = \frac{G''}{G'}$$

which is a measure of ratio of the dissipated energy to the stored energy.

Modulus is measured by using the glass transition temperature of the material. If a material is at a temperature below, especially well below, its glass transition temperature, the material exhibits more solid properties than non-Newtonian liquid properties. If a material is at a temperature above, especially well above, its glass transition temperature, the material exhibits more non-Newtonian liquid properties than solid properties.

The materials for use in the cleaning sheets of the present invention preferably have a glass transition temperature which is below the use temperature of the cleaning sheets of the present invention and a melting point and/or decomposition temperature above the use temperature of the cleaning sheets. More preferably, the materials for use in the cleaning sheets of the present invention preferably have a glass transition temperature below about 15°C and a melting point above about 200°C, even more preferably, the materials have a glass transition temperature below about 17°C and a melting point above about 175°C, most preferably the materials have a glass transition temperature below about 20°C and a melting point above about 150°C.

b. Differential Elongation Composite Cleaning Sheet

As shown in FIG. 1, in accordance with one embodiment of the present invention, the material (laminate web) **10** of the cleaning sheet of the present invention comprises at least three layers, webs or plies, disposed in a layered, face-to-face relationship, as shown in FIG. 1. The layers should be sufficiently thin to be processible as described herein, but no actual thickness (i.e., caliper) is considered limiting. A first outer layer and a second outer layer **20, 40** are known, respectively, as the first extensible web having a first elongation to break and as the second extensible web having a second elongation to break. The second outer layer preferably comprises the same material as the first outer layer but may be a different material. At least one third central layer **30** is disposed between the two outer layers. The laminate web **10** is processed by thermal calendaring as described below to provide a plurality of melt bond sites **50** that serve to bond the layers **20, 30** and **40**, thereby forming the constituent layers into a unitary web. While the laminate web **10** is disclosed primarily in the context of nonwoven webs and composites, in principle the laminate web **10** can be made out of any web materials that meet the requirements, (*e.g.*, melt properties, extensibility) as disclosed herein. For example, the constituent layers can be films, micro-porous films, apertured films, and the like.

Preferably, the first and second outer layers are nonwovens. Suitable nonwoven materials for the first and second outer layers include, but are not limited to, cellulosics, sponges (i.e., both natural and synthetic), formed films, battings, and combinations thereof. Preferably, the first and second outer layers each comprise materials selected from the group consisting of cellulosic nonwovens, formed films, battings, foams, sponges, reticulated foams, vacuum-formed laminates, scrims, and combinations thereof.

The first and second layers may comprise a variety of both natural and synthetic fibers or materials. As used herein, "natural" means that the materials are derived from plants, animals, insects or byproducts of plants, animals, and insects. The conventional

base starting material is usually a fibrous web comprising any of the common synthetic or natural textile-length fibers, or combinations thereof.

Nonlimiting examples of natural materials useful in the layers of the laminate web include, but are not limited to, silk fibers, keratin fibers and cellulosic fibers. Nonlimiting examples of keratin fibers include those selected from the group consisting of wool fibers, camel hair fibers, and the like. Nonlimiting examples of cellulosic fibers include those selected from the group consisting of wood pulp fibers, cotton fibers, hemp fibers, jute fibers, flax fibers, and combinations thereof. Cellulosic fiber materials are preferred in the present invention.

Nonlimiting examples of synthetic materials useful in the layers of the laminate web include those selected from the group consisting of acetate fibers, acrylic fibers, cellulose ester fibers, modacrylic fibers, polyamide fibers, polyester fibers, polyolefin fibers, polyvinyl alcohol fibers, rayon fibers, polyethylene foam, polyurethane foam, and combinations thereof. Examples of suitable synthetic materials include acrylics such as acrilan, creslan, and the acrylonitrile-based fiber, orlon; cellulose ester fibers such as cellulose acetate, arnel, and acele; polyamides such as nylons (e.g., nylon 6, nylon 66, nylon 610, and the like); polyesters such as fortrel, kodel, and the polyethylene terephthalate fiber, polybutylene terephalate fiber, dacron; polyolefins such as polypropylene, polyethylene; polyvinyl acetate fibers; polyurethane foams and combinations thereof. These and other suitable fibers and the nonwovens prepared therefrom are generally described in Riedel, "Nonwoven Bonding Methods and Materials," Nonwoven World (1987); The Encyclopedia Americana, vol. 11, pp. 147-153, and vol. 26, pp. 566-581 (1984); U. S. Patent No. 4,891,227, to Thaman et al., issued January 2, 1990; and U. S. Patent No. 4,891,228, each of which is incorporated by reference herein in its entirety.

Nonwovens made from natural materials consist of webs or sheets most commonly formed on a fine wire screen from a liquid suspension of the fibers. See C.A. Hampel et al., The Encyclopedia of Chemistry, third edition, 1973, pp. 793-795 (1973); The Encyclopedia Americana, vol. 21, pp. 376-383 (1984); and G.A. Smook, Handbook of Pulp and Paper Technologies, Technical Association for the Pulp and Paper Industry (1986); which are incorporated by reference herein in their entirety.

Natural material nonwovens useful in the laminate web of present invention may be obtained from a wide variety of commercial sources. Nonlimiting examples of suitable commercially available paper layers useful herein include Airtex®, an embossed airlaid cellulosic layer having a base weight of about 71 gsy, available from James River, Green

Bay, WI; and Walkisoft®, an embossed airlaid cellulosic having a base weight of about 75 gsy, available from Walkisoft U.S.A., Mount Holly, NC.

Additional suitable nonwoven materials include, but are not limited to, those disclosed in U. S. Patent Nos. 4,447,294, issued to Osborn on May 8, 1984; 4,603,176 issued to Bjorkquist on July 29, 1986; 4,981,557 issued to Bjorkquist on January 1, 1991; 5,085,736 issued to Bjorkquist on February 4, 1992; 5,138,002 issued to Bjorkquist on August 8, 1992; 5,262,007 issued to Phan et al. on November 16, 1993; 5,264,082, issued to Phan et al. on November 23, 1993; 4,637,859 issued to Trokhan on January 20, 1987; 4,529,480 issued to Trokhan on July 16, 1985; 4,687,153 issued to McNeil on August 18, 1987; 5,223,096 issued to Phan et al. on June 29, 1993 and 5,679,222, issued to Rasch et al. on October 21, 1997; 5,628,097 issued to Benson et al. on May 13, 1997; 5,916,661 and 5,658,639, both issued to Benson et al. on June 29, 1999; each of which is incorporated by reference herein in its entirety.

Methods of making nonwovens are well known in the art. Generally, these nonwovens can be made by air-laying, water-laying, meltblowing, coforming, spunbonding, or carding processes in which the fibers or filaments are first cut to desired lengths from long strands, passed into a water or air stream, and then deposited onto a screen through which the fiber-laden air or water is passed. The resulting layer, regardless of its method of production or composition, is then subjected to at least one of several types of bonding operations to anchor the individual fibers together to form a self-sustaining web. In the present invention the layers that comprise nonwovens can be prepared by a variety of processes including, but not limited to, air-entanglement, hydroentanglement, thermal bonding, and combinations of these processes.

The less extensible third central layer may also be a nonwoven as described above. Yet, the central layer **30** itself need not be thermally compatible with the outer layers. The central layer **30** need not even be melt processible. It can be, for example, a cellulosic material, such as paper, tissue, paper towel, paper napkins; a metallic material, such as a metallic foil; a woven or knit material, such as cotton or rayon blends; or a thermoset material, such as a polyester or aromatic polyamide film. The central layer **30** can be another nonwoven having suitable properties for processing into an apertured layer. If central layer **30** has a melting point, it is preferably at least about 20°C higher than the outer layers. The central layer **30**, however, need not have a melting point, and may simply experience softening at the calendaring temperatures required to bond the laminate. In certain central layer materials, such as metallic foils, there is not even any softening due to thermal processing of the web.

One of the unexpected advantages of the present invention is the discovery that novel web properties can be exhibited by the choice of central layer **30** disposed between the two outer layers. Preferably, the central layer material is selected from the group consisting of cellulosics, thermoplastic battings, metallic foils, metallic battings, sponges, formed films, and combinations thereof. Suitable materials for the central layer may include those discussed above. It is important, however, that the central layer have a third elongation break that is less than both the first and second outer layers. The wide range of possible central layer materials permits a surprising variety of structures of the present invention, each having beneficial application in a wide assortment of end uses. For example, when outer layers of nonwoven material are used with a central layer of metallic foil, the resulting laminate is a flexible, soft, formable, metallic web that is relatively silent when folded, crumpled or otherwise deformed. Such a material can be used in applications requiring electrical shielding, for example. When a central layer of tissue paper is used, the resulting laminate is a soft, bulky, absorbent web. Such a laminate is suitable for use as a wiping implement, for example. Further, since the laminate web **10** is formed without the use of thermoplastic adhesives, durable, garment-like properties can be obtained. Such laminates can be laundered a number of times before suffering unacceptable wear.

As shown in FIG. 2, central layer **30** is chosen such that when the constituent web layers of laminate web **10** are processed as detailed below, portions of central layer **30** in the region of the melt bond sites **50** separate to permit the first layer **20** to melt bond directly to the second outer layer **40** at the interface of the two materials **52** at melt bond sites **50**. Without being bound by theory, it is believed that the process of the present invention facilitates such separation of central layer **30** by shearing, cutting, or otherwise fracturing the central layer, and displacing the material of the central layer sufficiently to permit thermal bonding of the two outer layers. Thus, central layer **30** should be chosen to have properties that permit such cutting through, such as relatively low extensibility, relatively high frangibility, or relatively high deformability, such that the material of central layer **30** can be "squeezed" out of the region of thermal bond sites **50**.

Without being bound by theory, it is believed that to accomplish the bonding of the layers of the laminate web to form apertures therein, the thermal point calendaring described below should form thermal bond sites having a narrow width **W** dimension and a high aspect ratio. For example, FIG. 3 shows the melt area of a single melt bond site **50** having a narrow width dimension **W** and a high aspect ratio, i.e., the length, **L**, is much greater than the width, **W**. The length **L** should be selected to permit adequate bond area

while width **W** is sufficiently narrow such that the protuberance used to form the bond site (as described below) can cut, shear, or otherwise pierce the layers **20, 30, 40** at the region of the bond sites by the method described below. Width **W** can be between about 0.003 inches and 0.020 inches, but in a preferred embodiment, is between about 0.005 inches and 0.010 inches, and may be adjusted depending on the properties of central layer **30**.

It is believed that the aspect ratio can be as low as about 3 (i.e., ratio of **L/W** equals 3/1). It can also be between about 4 and 20. In one preferred embodiment, the aspect ratio was about 10. The aspect ratio of the melt bond sites **50** is limited only by the corresponding aspect ratio of the point bonding protuberances of the calendaring roller(s), as detailed below.

In a preferred embodiment, the longitudinal axis of each bond site, **l**, which corresponds directionally to the length dimension of bond site **50**, is disposed in a regular, repeating pattern oriented generally in the machine direction, **MD** as shown in FIG. 1. But the bond sites may be disposed in a regular, repeating pattern oriented in the cross machine direction, or randomly oriented in a mixture of cross and machine directions. For example, the bond sites **50** can be disposed in a "herringbone" pattern.

Another benefit of the present invention is obtained when the thermally bonded laminate web described above is stretched or extended in a direction generally orthogonal to the longitudinal axis, **l**, of melt bond sites **50**. The melt bonding at the melt bond sites **50** tends to make localized weakened portions of the web at the bond sites. Thus, as portions of the web **10** are extended in a direction generally orthogonal to the longitudinal axis **l** of bond sites **50**, the material at the bond site fails in tension and an aperture is formed. The relatively high aspect ratio of melt bond sites **50**, permits a relatively large aperture to be formed upon sufficient extension. When the laminate web **10** is uniformly tensioned, the result is a regular pattern of a plurality of apertures **60** corresponding to the pattern of melt bond sites **50**.

FIG. 4 shows a partially cut-away representation of an apertured laminate web useful for the present invention. As shown, the partial cut-away permits each layer or ply to be viewed in a plan view. The laminate web **10** shown in FIG. 4 is produced after the thermally bonded laminate is stretched in a direction orthogonal to the longitudinal axis of the melt bond sites, in this case, in the cross-machine direction, **CD**. As shown, where formerly were melt bond sites **50**, apertures **60** are produced as the relatively weak bond sites fail in tension. Also as shown, central layer **30** can remain generally uniformly distributed within laminate **10**, depending on the material properties of central layer **30**.

When apertures **60** are formed, the thermally bonded portions of layers **20, 30, 40** remain primarily on the portions of the aperture perimeters corresponding to the length dimension of bond sites **50**. Therefore, each aperture **60** does not have a perimeter of thermally bonded material, but only portions remain bonded, represented as **62** in FIG. 4. One beneficial property of such a laminate web is that once apertured, fluid communication with the central layer is facilitated. Thus, an absorbent central layer **30** can be used between two relatively non-absorbent outer layers, and the laminate **10** could be an absorptive wiper with a relatively dry to the touch outer surface.

FIG. 5 is a schematic representation of the cross-section denoted in FIG. 4. As shown, apertures **60** form when the laminate web is elongated in the direction **T**.

In certain preferred embodiments, the laminate web is characterized by having from about 10% to about 20% of the surface area be "open area." As used herein, "open area" means that the web is apertured or hole-containing such that the amount of material necessary to cover a certain area is minimized due expansion of the web that takes place after stretching/ring rolling. More preferably, the open area of the web is from about 11% to about 17%.

Another benefit of the articles of the present invention that is derived when the laminate web is extended as described with reference to FIG. 4, is that the central layer **30** that has an elongation to break less than either of the two outer layers fails in tension at a lower extensibility than does either of the outer layers. Thus, when the laminate is extended generally orthogonal to the longitudinal axis, l, of melt bond sites **50**, outer layers **20** and **40** extend to form apertures. However, central layer **30**, which has an elongation to break less than that of the outer layers, fractures upon sufficient extension, such that after extension central layer 30 is no longer uniformly distributed over the non-apertured regions of the laminate web 10.

An example of one embodiment of a web having a central layer having an elongation to break less than either of the two outer layers is shown partially cut-away in FIG. 5. The partial cut-away permits each layer or ply to be viewed in a plan view. As shown, after extension, central layer 30 becomes fragmented, forming discontinuous regions of the central layer material. These discontinuous regions may be relatively uniformly distributed, such as in rows as shown in FIG. 5, or may be relatively randomly distributed, depending on the pattern of melt bond sites **50** and the method of extension employed. One example of a web **10** having a structure similar to that shown in FIG. 5 is a web having outer layers of relatively extensible nonwovens, with a central layer of relatively low extensibility tissue paper.

A surprising benefit of the laminate web structure described in FIG. 6 is the presence of distinct regions in the non-apertured portion of the web being differentiated by at least one property selected from the group consisting of basis weight, thickness, density, and combinations thereof. As shown in the cross-section of FIG. 7, several such regions can be differentiated. In a preferred embodiment, the regions are visually distinct, giving the laminate web an aesthetically pleasing look and feel that is particularly useful in the articles of the present invention. The regions may also give the laminate a garment-like or knit-like texture.

With reference to FIG. 7, several structurally distinct regions can be identified in the cross-section shown. The region denoted **64** corresponds to the aperture **60**. In the non-apertured area of the web, a region **66** is a relatively high basis weight region comprising central layer **30**. Region **68** represents the portion of the laminate web in which central layer **30** has fractured and separated, *i.e.*, is no longer fully present, forming a relatively low basis weight region of web **10**. In general, the higher basis weight regions will also be correspondingly higher density regions, but need not be so. For example, a post-extension embossing process can be applied to web **10** to form regions of multiple densities in addition to the regions of multiple basis weight. For either the high basis weight regions or the high density regions, often the differences can be discernible by simply rubbing between the fingers.

In general, for a laminate web **10** having generally parallel rows of melt bond sites **50** extending in the machine direction **MD**, which correspondingly form generally parallel rows of apertures when extended, and having a central layer with a lower elongation to break than the outer layers, the resulting extended, apertured laminate web **10** is characterized by generally low basis weight, low density regions between the apertures in the machine direction, **MD**, *e.g.*, region **68** in FIGs. 6 and 7. Likewise, the laminate web **10** is characterized by relatively high basis weight, high density regions between adjacent rows of apertures in the cross-machine direction, **CD**, *e.g.*, region **66** in FIG. 7. By choice of central layer material **30** and possibly post laminating operations, *e.g.*, an embossing process, the thickness of the laminate web can likewise be varied, the thicker regions generally corresponding to the higher density regions.

Another embodiment of a laminate web useful for the present invention utilizes nonwoven webs as the outer layers is characterized by distinct regions differentiated by fiber orientation. Differential fiber orientation can be achieved by providing for localized regions within the web that experience greater extension than other regions. For example, by locally straining the web **10** to a greater degree in the regions corresponding to regions

68 in FIG. 6, regions of significant fiber reorientation are formed. Such localized straining is possible by the method of the present invention detailed below.

FIG. 8 is a photomicrograph showing in magnified detail a web of the present invention which has been extended to form apertures, and locally extended to produce regions **68** of fiber reorientation. As can be seen in FIG. 8, by locally extending portions of the web to a greater extent than others, the apertures formed thereby can be of different sizes. Thus, the region denoted generally as **70** in FIG. 8 has undergone more strain (i.e., local extension) than the region denoted by **72**. Thus, the apertures in region **70** are larger than those in region **72**, and the basis weight of the nonwoven web material in region **72** is less than the basis weight of the nonwoven web in region **70**. In addition to the difference in basis weight due to localized strain differentials, the laminate web of the present invention can also exhibit distinct regions **68** of fiber reorientation. In these regions, the fibers have been reoriented from a generally random orientation to a predominant orientation in the direction of extension.

To make a web **10** as shown in FIG. 6, central layer **30** can be any of a great number of dissimilar materials. For example, if outer layers **20** and **40** are nonwoven webs having a relatively high elongation to break, central layer **30** can be paper, tissue paper, thermoplastic film, metal foil, closed or open cell foam, or any other material that has a relatively low elongation to break compared to the two outer layers. The outer layer materials may themselves be dissimilar, with the only constraint being that the central layer be relatively less extensible in the direction of extension to form apertures.

Additionally, more than one central layer **30** can be used with beneficial results. For example, a laminate web comprising a cellulosic tissue central layer and an additional central layer comprising a polymeric film wherein both central layers are disposed between nonwoven first and second outer layers can produce an absorptive wiping article with one side being relatively more absorptive than the other. If the additional polymeric film central layer is a three-dimensional formed film, the film side can provide added texture to the laminate that is beneficial in many wiping applications. Macroscopically-expanded, three-dimensional formed films suitable for use in the present invention include those described in commonly-assigned U.S. Pat. No. 3,929,135 issued to Thompson on December 30, 1975, and U.S. Pat. No. 4,342,314 issued to Radel et al. on August 3, 1982, both patents hereby incorporated herein by reference.

The (or "a") central layer can also be elastomeric, and can be an elastomeric macroscopically-expanded, vacuum-formed, three-dimensional formed film, such as described in commonly-assigned U.S. Ser. No. 08/816,106, entitled "Tear Resistant

Porous Extensible Web" filed by Curro et al. on March 14, 1997, and hereby incorporated herein by reference. Further, the (or "a") central layer can be a three-dimensional formed film having micro-apertures such as described in commonly-assigned U.S. Pat. No. 4,629,643 issued to Curro et al. on December 16, 1986, and 4,609,518, issued to Curro et al. on September 2, 1986, both of which are hereby incorporated herein by reference.

The (or "a") central layer can be a web material having a strainable network as disclosed in U.S. Pat. No. 5,518,801 issued to Chappell et al. on May 21, 1996, and hereby incorporated herein by reference. Such a web can be a structural elastic-like film (SELF) web, formed by, for example, embossing by mating plates or rolls.

The (or "a") central layer can be an absorbent open cell foam web material. Particularly suitable absorbent foams for high performance absorbent articles such as diapers have been made from High Internal Phase Emulsions (hereafter referred to as "HIPE"). See, for example, U.S. Patent 5,260,345 (DesMarais et al), issued November 9, 1993 and U.S. Patent 5,268,224 (DesMarais et al), issued December 7, 1993, hereby incorporated herein by reference. These absorbent HIPE foams provide desirable fluid handling properties, including: (a) relatively good wicking and fluid distribution characteristics to transport the imbibed urine or other body fluid away from the initial impingement zone and into other regions of the foam structure to allow for subsequent gushes of fluid to be accommodated; and (b) a relatively high storage capacity with a relatively high fluid capacity under load, i.e. under compressive forces.

The central layer **30** may further comprise absorbent gelling materials. For example, supersorbers or hydrogel materials may provide for superior absorbency when the laminate web of the present invention is used as an absorbent wipe or a core in a disposable absorbent article of the present invention. By "hydrogel" as used herein is meant an inorganic or organic compound capable of absorbing aqueous fluids and retaining them under moderate pressures. For good results the hydrogels should be water insoluble. Examples are inorganic materials such as silica gels and organic compounds such as cross-linked polymers. Cross-linking may be by covalent, ionic, van der Waals, or hydrogen bonding. Examples of polymers include polyacrylamides, polyvinyl alcohol, ethylene maleic anhydride copolymers, polyvinyl ethers, hydroxypropyl cellulose, carboxymethyl cellulose, polyvinyl pyridine and the like. Suitable gelling materials are described below in the "optional ingredients" that relates to the personal care articles of the present invention. It should be understood, however, that such gelling materials may also be utilized in each of the articles of the present invention, irrespective of the intended use of the article.

The structure of the laminate web is particularly useful in the assembly of the articles of the present invention since the web can be made of dissimilar materials without the use of adhesive for joining. The plurality of melt bond sites **50** are sufficient to keep the component webs together in the laminate web, so that the laminate web behaves as a unitary web for processing integrity and use, without unwanted delamination. However, in some embodiments, and for certain materials, it may be beneficial to apply adhesive between at least two of the constituent layers.

Method of Making The Laminate Web

Referring to FIG. 9 there is schematically illustrated at **100** a process for making a laminate web of the present articles.

A first relatively extensible web **120** is unwound from a supply roll **104** and travels in a direction indicated by the arrows associated therewith as the supply roll **104** rotates in the direction indicated by the arrows associated therewith. Likewise a second relatively extensible web **140** is unwound from supply roll **105**. A central layer **130** is likewise drawn from supply roll **107**. The three components (or more, if more than one central layer is used) pass through a nip **106** of the thermal point bond roller arrangement **108** formed by rollers **110** and **112**.

Either outer layer can comprise a formed film, such as a three-dimensional formed film having micro-apertures such as described in commonly-assigned U.S. Pat. No. 4,629,643 issued to Curro et al. on December 16, 1986, and 4,609,518, issued to Curro et al. on September 2, 1986, both of which are hereby incorporated herein by reference.

In a preferred embodiment, both outer layers comprise nonwoven materials, and may be the identical. The nonwoven material may be formed by known nonwoven extrusion processes, such as, for example, known meltblowing processes or known spunbonding processes, and passed directly through the nip **106** without first being bonded and/or stored on a supply roll. However, in a preferred embodiment, the nonwoven webs are themselves thermally point bonded (consolidated) webs commercially available on supply rolls.

The nonwoven web outer layer(s) may be elastic or nonelastic so long as the third central layer is less extensible than both the first and second outer layers. The nonwoven web may be any melt-fusible web, including a spunbonded web, a meltblown web, or a bonded carded web. If the nonwoven web is a web of meltblown fibers, it may include meltblown microfibers. The nonwoven web may be made of fiber forming polymers such as, for example, polyolefins. Exemplary polyolefins include one or more of polypropylene, polyethylene, ethylene copolymers, propylene copolymers, and butene

copolymers. The nonwoven web can have a basis weight between about 10 to about 60 grams per square meter (gsm), and more preferably about 15 to about 30 gsm.

The nonwoven outer layers may themselves each be a multilayer material having, for example, at least one layer of a spunbonded web joined to at least one layer of a meltblown web, a bonded carded web, or other suitable material. For example, the nonwoven web may be a multilayer web having a first layer of spunbonded polypropylene having a basis weight from about 0.2 to about 8 ounces per square yard, a layer of meltblown polypropylene having a basis weight from about 0.2 to about 4 ounces per square yard, and a second layer of spunbonded polypropylene having a basis weight from about 0.2 to about 8 ounces per square yard. Alternatively, the nonwoven web may be a single layer of material, such as, for example, a spunbonded web having a basis weight from about 0.2 to about 10 ounces per square yard or a meltblown web having a basis weight from about 0.2 to about 8 ounces per square yard.

The nonwoven web outer layers may also be a composite made up of a mixture of two or more different fibers or a mixture of fibers and particles. Such mixtures may be formed by adding fibers and/or particulates to the gas stream in which the meltblown fibers or spunbond fibers are carried so that an intimate entangled co-mingling of fibers and other materials, e.g., wood pulp, staple fibers and particles occurs prior to collection of the fibers.

Prior to processing the laminate web as described herein, the outer cover of the fibers of the respective layers can be joined by bonding to form a coherent web structure. Suitable bonding techniques include, but are not limited to, chemical bonding, ultrasonic bonding, thermobonding, such as point calendering, hydroentangling, and needling.

Referring to FIGs. 9 and 10, the nonwoven thermal bond roller arrangement **108** preferably comprises a patterned calendar roller **110** and a smooth anvil roller **112**. One or both of the patterned calendar roller **110** and the smooth anvil roller **112** may be heated and the pressure between the two rollers may be adjusted by well known means to provide the desired temperature, if any, and pressure to concurrently displace central layer **30** at melt bond sites, and melt bond the two outer layers together at a plurality of bond sites.

The patterned calendar roller **110** is configured to have a circular cylindrical surface **114**, and a plurality of protuberances or pattern elements **116** which extend outwardly from surface **114**. The protuberances **116** are disposed in a predetermined pattern with each protuberance **116** being configured and disposed to displace central layer **30** at melt bond sites, and melt bond the two outer layers together at a plurality of

locations. One pattern of protuberances is shown in FIG. 11. As shown, the protuberances **116** have a relatively small width, **WP**, which can be between about 0.003 inches and 0.020 inches, but in a preferred embodiment is about 0.010 inches. Protuberances can have a length, **LP**, of between about 0.030 inches and about 0.200 inches, and in a preferred embodiment has a length of about 0.100 inches. In a preferred embodiment, the protuberances have an aspect ratio of 10. The pattern shown is a regular repeating pattern of staggered protuberances, generally in rows, each separated by a row spacing, **RS**, of about between about 0.010 inches and about 0.200 inches. In a preferred embodiment, row spacing **RS** is about 0.060 inches. The protuberances can be spaced apart within a row by a protuberance spacing, **PS** generally equal to the protuberance length, **LP**. But the spacing and pattern can be varied in any way depending on the end product desired.

As shown in FIG. 10, patterned calendar roller **110** can have a repeating pattern of protuberances **116** which extend about the entire circumference of surface **114**. Alternatively, the protuberances **116** may extend around a portion, or portions of the circumference of surface **114**. Likewise, the protuberances **116** may be in a non-repeating pattern, or in a repeating pattern of randomly oriented protuberances.

The protuberances **116** are preferably truncated conical shapes which extend radially outward from surface **114** and which have rectangular or somewhat elliptical distal end surfaces **117**. Although it is not intended to thereby limit the scope of the present invention to protuberances of only this configuration, it is currently believed that the high aspect ratio of the melt bond site **50** is only achievable if the protuberances likewise have a narrow width and a high aspect ratio at the distal end surfaces **117**, as shown above with reference to FIG. 11. Without being bound by theory, it is believed that other suitable shapes for distal ends **117** may include, but are not limited to circular, square, rectangular, etc., if they facilitate the bonding and aperturing of the laminate web. The roller **110** is preferably finished so that all of the end surfaces **117** lie in an imaginary right circular cylinder which is coaxial with respect to the axis of rotation of roller **110**.

The height of the protuberances should be selected according to the thickness of the laminate being bonded. In general, the height dimension should be greater than the maximum thickness of the laminate web during the calendaring process, so that adequate bonding occurs at the bond sites, and only at the bond sites.

Anvil roller **112**, is preferably a smooth surfaced, right circular cylinder of steel.

After passing through nip **106**, the three (or more) component webs **120**, **130**, and **140** have been formed into laminate web **10**. At this point in the process the outer layers

are thermally bonded and unapertured, as shown in FIGs. 1 and 2. Central layer(s) **30**, from web **130**, is apertured, having been displaced by protuberances **116** in nip **106**.

The laminate web **10** may be further processed to form apertures in the whole laminate web extending portions of the web in a direction orthogonal to the axis **l** of bond sites **50**. It is by this process that the open area of the web is formed. As shown in FIGs. 9 and 10, the axis **l** is generally parallel to the machine direction **MD** of the web being processed. Therefore, extension in the cross-direction **CD** at the bonded portions causes the bond sites **50** to rupture and open to form apertures in the web.

One method for forming apertures across the web is to pass the web through nip **130** formed by an incremental stretching system **132** employing opposed pressure applicators **134** and **136** having three-dimensional surfaces which at least to a degree are complementary to one another. Stretching of the laminate web may be accomplished by other methods known in the art, including tentoring, or even by hand. However, to achieve even strain levels across the web, and especially if localized strain differentials are desired, the incremental stretching system disclosed herein is preferred.

Referring now to FIG. 12, there is shown a fragmentary enlarged view of the incremental stretching system **132** comprising incremental stretching rollers **134** and **136**. The incremental stretching roller **134** includes a plurality of teeth **160** and corresponding grooves **161** which extend about the entire circumference of roller **134**. Incremental stretching roller **136** includes a plurality of teeth **162** and a plurality of corresponding grooves **163**. The teeth **160** on roller **134** intermesh with or engage the grooves **163** on roller **136**, while the teeth **162** on roller **136** intermesh with or engage the grooves **161** on roller **134**. The teeth of each roller are generally triangular-shaped, as shown in FIG. 13. The apex of the teeth may be slightly rounded, if desired for certain effects in the finished web.

With reference to FIG. 13, which shows a portion of the intermeshing of the teeth **160** and **162** of rollers **134** and **136**, respectively. The term "pitch" as used herein, refers to the distance between the apexes of adjacent teeth. The pitch can be between about 0.02 to about 0.30 inches, and is preferably between about 0.05 and about 0.15 inches. The height (or depth) of the teeth is measured from the base of the tooth to the apex of the tooth, and is preferably equal for all teeth. The height of the teeth can be between about 0.10 inches and 0.90 inches, and is preferably about 0.25 inches and 0.50 inches.

The teeth **160** in one roll can be offset by one-half the pitch from the teeth **162** in the other roll, such that the teeth of one roll (e.g., teeth **160**) mesh in the valley (e.g., valley **163**) between teeth in the mating roll. The offset permits intermeshing of the two rollers

when the rollers are "engaged" or in an intermeshing, operative position relative to one another. In a preferred embodiment, the teeth of the respective rollers are only partially intermeshing. The degree to which the teeth on the opposing rolls intermesh is referred to herein as the "depth of engagement" or "DOE" of the teeth. As shown in FIG. 13, the DOE, **E**, is the distance between a position designated by plane **P1** where the apexes of the teeth on the respective rolls are in the same plane (0% engagement) to a position designated by plane **P2** where the apexes of the teeth of one roll extend inward beyond the plane **P1** toward the valley on the opposing roll. The optimum or effective DOE for particular laminate webs is dependent upon the height and the pitch of the teeth and the materials of the web.

In other embodiments the teeth of the mating rolls need not be aligned with the valleys of the opposing rolls. That is, the teeth may be out of phase with the valleys to some degree, ranging from slightly offset to greatly offset.

As the laminate web **10** having melt bonded locations **50** passes through the incremental stretching system **132** the laminate web **10** can be subjected to tensioning in the **CD** or cross-machine direction causing the laminate web **10** to be extended in the **CD** direction. Alternatively, or additionally the laminate web **10** may be tensioned in the **MD** (machine direction). The tensioning force placed on the laminate web **10** can be adjusted (*e.g.*, by adjusting DOE) such that it causes the melt bonded locations **50** to separate or rupture creating a plurality of apertures **60** coincident with the melt bonded locations **50** in the laminate web **10**. However, portions of the melt bonds of the laminate web **10** remain, as indicated by portions **62** in FIG. 4, thereby maintaining the nonwoven web in a coherent condition even after the melt bonded locations rupture.

After being subjected to the tensioning force applied by the incremental stretching system **132**, the laminate web **10** includes a plurality of apertures **60** which are coincident with the melt bonded regions **50** of the laminate web. As mentioned, a portion of the circumferential edges of apertures **60** include remnants **62** of the melt bonded locations **60**. It is believed that the remnants **60** help to resist further tearing or delamination of the laminate web.

Instead of two substantially identical rolls **134** and **136**, one or both rolls can be modified to produce extension and additional patterning. For example, one or both rolls can be modified to have cut into the teeth several evenly-spaced thin planar channels **246** on the surface of the roll, as shown on roll **236** in FIG. 14. In FIG. 14 there is shown an enlarged view of an alternative incremental stretching system **232** comprising incremental stretching rollers **234** and **236**. The incremental stretching roller **234** includes a plurality

of teeth **260** and corresponding grooves **261** which extend about the entire circumference of roller **234**. Incremental stretching roller **236** includes a plurality of teeth **262** and a plurality of corresponding grooves **263**. The teeth **260** on roller **234** intermesh with or engage the grooves **263** on roller **236**, while the teeth **262** on roller **236** intermesh with or engage the grooves **261** on roller **234**. The teeth on one or both rollers can have channels **246** formed, such as by machining, such that regions of undeformed laminate web material may remain after stretching. A suitable pattern roll is described in U.S. Patent No. 5,518,801, issued May 21, 1996, in the name of Chappell, et al., the disclosure of which is incorporated herein by reference.

Likewise, the incremental stretching can be by mating rolls oriented as shown in FIG. 15. Such rolls comprise a series of ridges **360**, **362**, and valleys, **361**, **363** that run parallel to the axis, **A**, of the roll, either **334** or **336**, respectively. The ridges form a plurality of triangular-shaped teeth on the surface of the roll. Either or both rolls may also have a series of spaced-apart channels **346** that are oriented around the circumference of the cylindrical roll. Rolls as shown are effective in incrementally stretching a laminate having bond sites **50** having the axis **l** oriented generally parallel to the cross-machine (**CD**) direction of the web as its being processed.

In one embodiment, the method of the making the laminate web of the articles of the present invention can comprise both CD and MD incremental stretching. As shown in FIG. 16, two pairs of incremental stretching rolls can be used in line, such that one pair (**232**, which, as shown in FIG. 16 includes a series of spaced-apart channels **246**) performs CD stretching, and another pair, **332** performs MD stretching. By this method many interesting fabric-like textures can be made to be incorporated into the articles of the present invention. The resulting hand and visual appearance make such fabric-like webs ideal for use in the articles of the present invention.

c. Solid State Post Formation Technology

Another embodiment of the cleaning sheets of the present invention comprises a material which is a multiply substrate having one or more hydrophobic outer plies, preferably polyethylene and/or nylon, preferably nylon-6, and one or more hydrophilic inner plies, preferably cellulosic, more preferably absorbent.

Cleaning sheets in accordance with the present invention comprising such material has been found to surprisingly resist folding, especially refolding upon itself even after an initial fold has been formed in the cleaning sheet. Further, such cleaning sheets tend to unfold from a folded state upon use.

Apertures in Cleaning Sheets

The cleaning sheets of the present invention may comprise apertures. The apertures are preferably formed and/or arranged in such a way as to reduce the tendency of the cleaning sheet to fold, especially refold upon itself even after an initial fold has been formed in the cleaning sheet.

As shown in FIG. 18, a cleaning sheet **10'** in accordance with the present invention comprises apertures **60'** preferably formed and/or arranged in such a way as to reduce the tendency of the cleaning sheet **10'** to fold. Each aperture **60'** preferably has a major axis **A** and a minor axis **B**, preferably the major axis **A** is at least 1.5 times the length of the minor axis **B**. A fold line **F-G** when formed in such a cleaning sheet **10'** as shown in FIG. 18 is preferably formed substantially parallel to the minor axis **B** of the apertures. Substantially parallel to the minor axis of the aperture means that the fold line is positioned at an angle less than 90°, preferably less than 70°, more preferably less than 45° to the minor axis.

The apertures may be made by any suitable process known in the art. A nonlimiting example of a suitable process is described hereinabove.

Encasement

In addition to materials and apertures useful in the cleaning sheets of the present invention, as shown in FIG. 19 a cleaning sheet **10"** in accordance with the present invention may include an outer sheet **400** (coversheet) and an inner sheet **410** wherein the outer sheet **400** wholly or partially, preferably wholly, encases the inner sheet **410**.

The outer sheet **400** preferably is hydrophobic and the inner sheet **410** is preferably hydrophilic.

The outer sheet **400** can be made hydrophobic by any process known in the art, such as by printing the sheet with a hydrophobic ink, applying a paint and/or other materials to render the sheet hydrophobic.

In a preferred embodiment as shown in FIG. 20, the outer sheet **400** comprises crepe **420**, preferably a discrete layer of crepe.

Preferably, cleaning sheets comprising outer sheets that wholly or partially encase inner sheets are arranged such that the outer sheets and inner sheets can contract and/or expand independent of one another. More preferably, the outer sheets and inner sheets are arranged such that when an initial fold line is formed in the cleaning sheet the fold line in the outer and inner sheets are aligned, and then upon use of the cleaning sheet the fold line in the outer and inner sheets become nonaligned such that the cleaning sheet resists folding.

Cleaning/Refreshment Composition

The cleaning sheets of the present invention preferably comprise a cleaning/refreshment composition releasably absorbed in the cleaning sheet. By "releasably contains" means that the composition is effectively released from the cleaning sheet onto an article, preferably soiled fabrics as part of a non-immersion cleaning and fabric refreshment process as described herein. This release occurs mainly by volatilization of the composition from the cleaning sheet.

The cleaning/refreshment composition preferably comprises water and a member selected from the group consisting of surfactants, perfumes, preservatives, bleaches, auxiliary cleaning agents, organic solvents and mixtures thereof. The preferred organic solvents are glycol ethers, specifically, methoxy propoxy propanol, ethoxy propoxy propanol, propoxy propoxy propanol, butoxy propoxy propanol, butoxy propanol and mixtures thereof. The surfactant is preferably a nonionic surfactant, such as an ethoxylated alcohol or ethoxylated alkyl phenol, and is present at up to about 2%, by weight of the cleaning/refreshment composition. Typical fabric cleaning refreshment/compositions herein can comprise at least about 80%, by weight, water, preferably at least about 90%, and more preferably at least about 95% water.

The Examples below give specific ranges for the individual components of preferred cleaning/refreshment compositions for use herein. A more detailed description of the individual components of the cleaning/refreshment compositions, that is, the organic solvents, surfactants, perfumes, preservatives, bleaches and auxiliary cleaning agents can be found in U.S. Patent No. 5,789,368, which issued on August 4, 1998 to You et al. and in U.S. Patent No. 5,591,236, which issued on January 7, 1997 to Roetker. The entire disclosure of the You et al. and the Roetker patents are incorporated herein by reference. Additionally, cleaning/refreshment compositions are described in co-pending U.S. Patent Application No. 08/789,171, which was filed on January 24, 1997, in the name of Trinh et al. The entire disclosure of the Trinh et al. Application is incorporated herein by reference.

It is especially preferred that the cleaning/refreshment compositions of this invention include a shrinkage reducing composition, which is preferably selected from the group consisting of ethylene glycol, all isomers of propanediol, butanediol, pentanediol, hexanediol and mixtures thereof, and more preferably selected from the group consisting of neopentyl glycol, polyethylene glycol, 1,2-propanediol, 1,3-butanediol, 1-octanol and mixtures thereof. The shrinkage reducing composition is preferably neopentyl glycol or 1,2-propanediol, and is more preferably 1,2-propanediol. The ratio of shrinkage reducing composition to cleaning/refreshment composition is preferably from about 1:2 to about

1:5, preferably from about 1:2 to about 1:4, more preferably from about 1:3 to about 1:4, and most preferably about 1:3.6.

In addition to the above ingredients, the cleaning/refreshment composition may optionally comprise a bleaching agent, preferably hydrogen peroxide.

Kits

The cleaning sheets of the present invention may be incorporated into kits. Such kits comprise a plurality of cleaning sheets.

In another embodiment, a kit in accordance with the present invention comprises one or more cleaning sheets and a contaiment bag, preferably a reusable containment bag, more preferably a fabric reusuable containment bag. Nonlimiting examples of such containment bags are described in U.S. Patent Nos. 5,789,368 and 5,681,355 and U.S. Patent Application Serial No. 60/190,640.

In another embodiment, a kit in accordance with the present invention comprises one or more cleaning sheets and a stain remover system. Nonlimiting examples of stain remover systems are described in U.S. Patent Nos. 5,891,197, 5,872,090, 5,849,039, 5,789,368 and 5,681,355 and U.S. Patent Application Serial No. 60/190,640.

Consumer Signals

The cleaning sheets of the present invention may comprise a consumer signal component to communicate to the consumer the state of the cleaning sheet. For example, the consumer signal may communicate to the consumer that the cleaning sheet has been used and/or partially used or in other words that the cleaning composition of the cleaning sheet has been consumed and/or partially consumed. In another example, the consumer signal may communicate that the cleaning sheet has not been used or in other words that the cleaning composition of the cleaning sheet has not been consumed.

The consumer signal component comprises a material that is capable of being sensed by a consumer's sensory system, such as sight, touch, smell and/or hearing.

Such consumer signal components may be noticeable prior to use and unnoticeable upon use (consumption) and/or the consumer signal components may be unnoticeable prior to use and noticeable upon use (consumption).

Nonlimiting examples of such consumer signal components include the following, visual marks such as trademarks, logos, and the like that are incorporated into the cleaning sheet, colors such that the cleaning sheet changes colors upon use (consumption), colors such that lint, dirt and/or other particulates are visible upon the cleaning sheet after use (consumption), perfume such that a perfume scent is either noticeable prior to use (consumption) or noticeable after use (consumption), additional

materials incorporated into and/or on the cleaning sheet such that the additional materials separate from the cleaning sheet upon use (consumption). Nonlimiting examples of such additional materials include particulates, crystals, nonwoven materials and/or woven materials.

The following Examples further illustrate the invention, but are not intended to be limiting thereof.

EXAMPLE I

Cleaning and Refreshing Compositions

Fabric cleaning/refreshment compositions according to the present invention, for use in a containment bag, are prepared as follows:

Ingredient	% (wt.)
Emulsifier (TWEEN 20)*	0.5
Perfume	0.5
KATHON®	0.0003
Sodium Benzoate	0.1
Water	Balance

*Polyoxyethylene (20) sorbitan monolaurate available from ICI Surfactants.

Additionally, preferred compositions for use in the in-dryer cleaning/refreshment step of the process herein are as follows.

Ingredient	% (wt.)	Range (% wt.)
Water	99.0	95.1-99.9
Perfume	0.5	0.05-1.5
Surfactant	0.5	0.05-2.0
Ethanol or Isopropanol	0	Optional to 4%
Solvent (e.g. BPP)	0	Optional to 4%

pH range from about 6 to about 8.

Additionally, preferred compositions for use in the in-dryer cleaning/refreshment step of the process herein are as follows:

Ingredient	% (wt.)	% (wt.)	% (wt.)	% (wt.)
Water	97.63	98.85	77.22	96.71
Perfume	0	0.38	0.38	0

Surfactant	0.285	0	0	0.285
Solvent (e.g. BPP)	2.0	0	0	2.0
KATHON®	0.0003	0	0	0
Emulsifier (TWEEN 20)*	0	0.5	0.38	0
Amine Oxide	0.0350	0	0	0.0350
$MgCl_2$	0.045	0	0	0
$MgSO_4$	0	0	0.058	0
Hydrogen Peroxide	0	0	0	0.6
Citric Acid	0	0	0	0.05
Proxel GXL	0	0.08	0.08	0
Bardac 2250	0	0.2	0.2	0
1,2-Propanediol	0	0	21.75	0

*Polyoxyethylene (20) sorbitan monolaurate available from ICI Surfactants.

Besides the other ingredients, the foregoing compositions can contain enzymes to further enhance cleaning performance, as described in the Trinh et al. patent incorporated herein above.